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SCABBY APPLES FROM CHECK PLATS IN DUSTING AND SPRAYING EXPERIMENTS

DUSTING EXPERIMENTS IN PEACH AND APPLE ORCHARDS IN 1920

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Dusting Experiments in Peach and Apple Orchards in 1920

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The dusting experiments were co-operative between the Departments of Plant Pathology and Horticulture and were conducted in both peach and apple orchards.* The experiments were planned, primarily, with the view of obtaining additional data on the efficiency of various dusting materials in the control of apple scab, to test the copper-lime mixtures for bitter-rot and to determine the relative importance of a varying number of applications of sulfur dust in the control of peach diseases and insects.

A large Niagara, model D duster was used for all of the dust applications and adequate power sprayers for all of the spray applications. Both apples and peaches were dusted from both sides of the rows. The dusting mixtures, which were furnished ready mixed by the Niagara Sprayer Co., were as follows:

Sulfur dust, 80-10-10, containing 80 pounds of dusting sulfur, 10 pounds of arsenate of lead and 10 pounds of hydrated lime.

Copper-lime dust, 10-10-80, containing 10 pounds of dehydrated copper sulfate, 10 pounds of arsenate of lead and 80 pounds of hydrated lime.

Copper-lime dust, 5-10-85, similar to the former but with decrease in copper and increase in lime as indicated by the formula.

Bordeaux dust, also called potato dusting mixture, containing 25 pounds "bordo" (22% available copper), 10 pounds arsenate of lead and 65 pounds of hydrated lime.

EXPERIMENTS ON PEACHES

The work on peaches was conducted in three orchards at Crozet, Virginia. There were five plats in each orchard, three were dusted with sulfur dust, one was sprayed with arsenate of lead and self-boiled lime-sulfur, and one served as a check. The number of applications on the dusted plats varied from 5 to 8, one plat receiving 5 applications, one 6, and one 8. The number of applications on the spray plats was three, which is the standard schedule for this State. The first application was with arsenate of lead and

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lime, the second, with self-boiled lime-sulfur and arsenate of lead, and the third with self-boiled lime-sulfur alone. The dates of the spray and dust applications on the various plats are indicated by the letter x in Table 1.

TABLE 1.—*Schedule of applications in peach orchards.*

Plat	Apr. 29	May 15	Jne. 19	Jne. 26	Jly. 5	Jly. 10	Jly. 17	Jly. 30
Sulfur dust 5x	x	x	x				x	x
Sulfur dust 6x	x	x	x		x		x	x
Sulfur dust 8x	x	x	x	x	x	x	x	x
Spray	x	x			x			
Check								

The data on peaches were obtained from counts of all peaches from 6 trees in each plat at harvest. In no case did the total number of peaches to a plat fall below 1,000, the average number per plat in Orchard No. 1 being 4,039; in Orchard No. 2, 1,716, and in Orchard No. 3, 1,178.

Scab was the most prevalent disease and the injury caused by the green soldier-bug the most prevalent insect injury. Brown-rot, unfortunately, was slight in all three orchards. The extra number of dust applications were planned with the control of this disease in view. Next to scab, the most common cause of defective fruits was a type of cracking, which was largely confined to the dust plats. The percentages of defective fruits due to the various causes, and of sound fruits are shown in Table 2.

In making comparisons of the percentages in the table, the differences in the number of applications on the plats should be borne in mind. It is probably to be expected that the spray plat, which received three applications, should show more scab than the dust plats, which received from 5 to 8. The percentages of scab, however, do not give a correct impression of the commercial results. The figures show total scab, every peach that had any scab spots being included. Most of the infection in the spray and dust plats was of no commercial importance. The commercial injury due to scab amounted to less than one percent in the spray plat in Orchard No. 1, to less than one-half of one percent in this plat in Orchard No. 3, and there was no loss in the spray plat in Orchard No. 2. The control of scab from the commercial standpoint was, therefore, practically the same in the spray and dust plats. There was little difference between the three dust plats; 5 applications gave as satisfactory results in the control of scab and brown-rot as did 6 and 8.

A thorough test of the materials in the control of brown-rot was not obtained owing to the slight amount of infection. There was little difference between the results of the spray and dust applications and both were satisfactory.

Curculio infestation was also too slight to give any indications as to the efficiency of the materials.

TABLE 2.—*Percentages of defective and sound fruits in peach dusting experiments in 1920. The variety was Elberta in orchards No. 1 and No. 2 and Wonderful in No. 3.*

Classes of Fruit	Treatment of Plats	Orchard No.		
		1	2	3
affected with scab	Check	51.5	94.7	78.7
	Spray	15.6	2.1	19.0
	Dust 5x	.2	4.1	3.4
	Dust 6x	.1	1.7	3.4
	Dust 8x	0	1.3	1.7
affected with brown-rot	Check	3.7	6.9	3.0
	Spray	.2	.2	.5
	Dust 5x	.2	.3	.7
	Dust 6x	.4	.1	.6
	Dust 8x	.7	1.1	1.3
damaged by fruit-crack	Check	.9	0	3.5
	Spray	.2	.5	1.9
	Dust 5x	15.7	10.3	15.7
	Dust 6x	13.0	7.2	24.5
	Dust 8x	16.1	13.7	21.3
injured by green soldier-bug	Check	12.0	5.7	2.6
	Spray	10.9	5.9	2.4
	Dust 5x	6.6	7.4	2.9
	Dust 6x	6.7	8.1	5.5
	Dust 8x	5.3	5.3	3.4
injured by curculio	Check	.6	2.5	4.3
	Spray	1.2	2.7	8.2
	Dust 5x	.1	2.7	2.7
	Dust 6x	.3	2.4	2.3
	Dust 8x	.1	1.4	4.1
sound fruit	Check	39.5	.8	15.6
	Spray	73.1	88.6	69.6
	Dust 5x	78.0	76.2	75.7
	Dust 6x	79.9	80.1	65.5
	Dust 8x	78.7	77.4	70.3

The number of fruits injured by the green soldier-bug were greater than those injured by curculio, especially in Ochard No. 1. Here the dust applications seemed to have checked the injury to some extent, but no apparent measure of control was obtained in the other orchards with either dust or spray.

The fruit-crack which occurred in the dusted plats, and to a very slight extent in the spray plats and checks, was by far the most important injury from the commercial standpoint. Figure 1 shows the type of fruit-crack which occurred. They were most common at the stem ends of the fruits and extended in the long axis of the fruit with occasional cross checks as

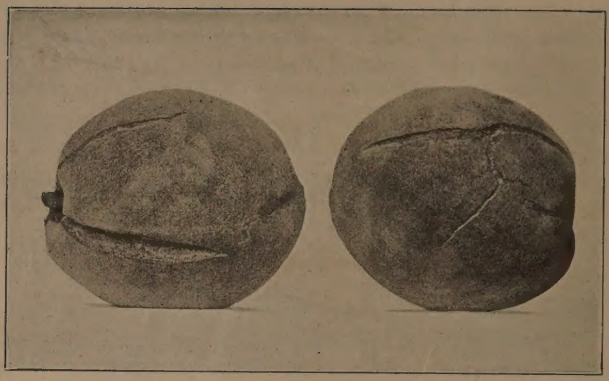

FIG. 1—FRUIT-CRACKS WHICH OCCURRED ON PEACHES IN THE DUSTED PLATS

shown in the peach on the right. The cracks were found on the exposed upper cheek of the fruits in all cases. The distribution of the damaged fruits on the trees was quite uniform, practically all of them being found on outer, lower limbs with few or none in the centers and tops of the trees. It was quite evident that these fruit-cracks were caused primarily by the dust mixtures. Evidences of excessive amounts of dust could usually be found around the cracks. Evidently the burning caused by the dust was greatly intensified by the excessive rainfall which occurred in the latter part of the season, and which brought about the rapid enlargement of the fruits and resulted in the separation of the cells and cracking along the points of injury. It is not believed that the severe fruit-crack experienced in these tests indicates that dusting is an unsafe practice under average conditions. The injury in this case was brought about, apparently, by a combination of excessive quantities of materials and unusual climatic conditions. The working distance between rows in peach orchards is small and it is a very easy matter to over-load the fruit on near branches with the dust.

A comparison with our previous results in dusting experiments on peaches is of interest and for this reason Table 3 is provided. The results obtained with dust and spray applications in the control of scab and brown-rot in 1919 and 1920 are shown. In order that the percentages of infection might be compared more readily, they have been converted into percentages of efficiency, which is the percentage of control of disease based on the percentage that occurred in the check plat. It will be noted under the scab column that the percentages of efficiency of the various sulfur dusts run uniformly high, the lowest being 92 with the 50-40-10 mixture in the Belle variety in 1919. It seems evident that sulfur dusts are very effective in the control of this disease. The results with brown-rot are not so uniform or

conclusive. The percentages of infection in the check plats have been too low in all cases except one, the Champion variety in 1919, to justify conclusions. In this case the dust applications did not control the disease satisfactorily. No spray plat was available for comparison in 1919, and in the 3 orchards in 1920 where both spray and dust plats were provided the percentages of infection were so low that but little reliance can be placed on the results as shown. Our experience with peach dusting therefore may be summed up in the statement that the dusting materials have given very satisfactory control of scab, and that the data with respect to the control of brown-rot and curculio are insufficient for drawing conclusions.

TABLE 3.—*Comparison of the results of dusting and spraying experiments on peaches in 1919 and 1920.*

Year	Variety	Material	No. of Applications	Percentage of Efficiency in Control of		Pcntge. of afctd. fruits in chk. plats
				Scab	Brown-rot	
1919	Belle	90- 0-10	3	95		Scab 26.4
		50-40-10	3	96		
		50-40-10	4	92		
	Carman	90- 0-10	3	99	76	Scab 57.5
		50-40-10	3	99	46	Rot 3.7
		50-40-10	4	99	35	
	Champion	90- 0-10	3		16	
		50-40-10	3		55	Rot 53.
		50-40-10	4		31	
1920	Elberta (orch'd No. 1)	Spray	3	70	95	Scab 51.5
		80-10-10	5	99	95	Rot 3.7
		80-10-10	6	99	89	
		80-10-10	8	100	81	
	Elberta (orch'd No. 2)	Spray	3	98	97	Scab 94.7
		80-10-10	5	96	96	
		80-10-10	6	98	99	Rot 6.9
		80-10-10	8	99	86	
	Wonderful	Spray	3	76	83	Scab 78.7
		80-10-10	5	96	77	
		80-10-10	6	96	80	Rot 3.
		80-10-10	8	98	57	

EXPERIMENTS ON APPLES

The experiments on apples were conducted in two orchards, one at Harrisonburg, where the control of scab was the principal object, and one at Crozet, where bitter-rot was the chief disease.

Apple scab control—Each plat consisted of about 14 trees of two varieties, Winesap and Stayman. The trees were eleven years old. Scab had been very severe in this orchard in 1919.

A total of seven applications were made on all plats, except the check, beginning with a delayed dormant application on April 9 and ending July 15. The pink application was made on April 23, the calyx on May 13, and subsequent applications on May 24, June 4, June 30, and July 15. Only the first five were considered necessary in scab control, the last two being for codling moth and bitter-rot.

The materials used in the dust and spray applications are shown in Table 2. The dry lime-sulfur was the Sherwin-Williams brand and was used at a dilution of 3 pounds to 50 gallons of water. This material was used for the first three applications on this plat and 4-5-50 Bordeaux mixture was used for the last four. The first three applications on the lime-sulfur plat were made with the standard material, diluted five quarts to 50 gallons of water, and the last four with 4-5-50 Bordeaux mixture. In the Bordeaux mixture plat the 3-10-50 formula was used for the first four applications and 4-5-50 for the last three. Lead arsenate was used in all applications, except the first two, on both spray and dusted plats.

Scab was the only disease present to any extent. There was no bitter-rot whatever, and codling moth was so slight as to be negligible. The few wormy apples were quite uniformly distributed over the plats. The summary of the data on scab is shown in Table 4. The percentages of apples affected with scab, for the two varieties, are shown in the first two columns, and the percentages of efficiency of the different materials, based on percentages of scab in the check plats, are shown in the last two columns.

Scab infection on Winesap was considerably more severe than on Stayman, about three times as much on the average. This is due to the difference in the susceptibility of the two varieties.

All three spray mixtures gave good control of scab, the Bordeaux mixture being apparently somewhat less efficient than the other two. Unfortunately there was no fruit of the Winesap variety in the lime-sulfur plat, and not enough in the dry lime-sulfur plat (only 68 apples) to serve as a basis for conclusions.

The sulfur dust was by far the most efficient of the three dust mixtures and this material compared very favorably with the spray mixtures in scab control, the percentages of efficiency being 88 for Winesap and 92 for Stayman. Neither the copper-lime nor Bordeaux dust gave sufficiently good con-

trol of scab to warrant their use, and both caused some russetting of the fruit. Some russetting was present in all of the spray plats also, but it was not severe enough to be commercially important. The sulfur dust was the only material that did not cause russetting.

TABLE 4.—*Percentages of apples affected with scab and relative efficiency of materials in dusting and spraying experiments in 1920.*

Treatment of Plats	Percentage of Scab		Percentage of Efficiency	
	Winesap	Stayman	Winesap	Stayman
Dry lime-sulfur and Bordeaux mixture	2.9*	.7	96	96
Lime-sulfur and Bordeaux mixture	no fruit	.9		95
Bordeaux mixture	4.7	1.8	93	91
Sulfur dust	8.1	1.6	88	92
Bordeaux dust	24.2	9.4	65	52
Copper-lime dust	31.1	9.3	55	53
Check	68.4	19.6		

*Only 68 apples in the entire plat. The number in other plats of the Winesap variety ranged from 471 to 3028, while the number in the Stayman plats ranged from 1708 to 3832.

The season was an unusual one and this should be borne in mind in the interpretation of results. The unusual feature was the lateness of scab infection. Although it was impossible to make frequent studies of the discharge of scab spores from the old leaves on the ground, owing to the work in other orchards, such observations as were made indicated that the period of greatest discharge came late in May. These indications were corroborated by the time of appearance of scab infections on foliage and fruit. It seems probable, therefore, that the fourth application, which was made on May 24, ten days after the calyx application, was the most important single application for scab control. The material used for this application on the dry lime-sulfur and life-sulfur plats was 4-5-50 Bordeaux mixture, and that on the Bordeaux mixture plat was 3-10-50 Bordeaux. It seems probable, therefore, that the excellent control of scab on the dry lime-sulfur plat should be attributed more to the Bordeaux mixture application on May 24 than to the previous applications of dry lime-sulfur. It is to be noted, in this connection, that the Michigan Agricultural Experiment Station has had poor results with the dry lime-sulfurs in scab control (see Michigan Agr. Exp. Sta. Quarterly for November, 1920).

TABLE 5.—*Comparison of the results of dusting and spraying experiments on apples in 1917, 1919 and 1920.*

Year	Variety	Material	No. of Applications	Pcntge. of Efficiency	Pcntge. afctd. fruits in chk. plats
CODLING MOTH					
1920	Albemarle Pippin	L. S. & B. M. 10-10-80 5-10-85	6 6 6	92 74 79	29.6
1919	Albemarle Pippin	L. S. & B. M. L. S. & B. M. B. Dust 80-10-10	4 4 4 4	93 98 92 93	16.4
1917	Reagan	L. S. 40-40-20	1 1	82 82	14.3
BITTER ROT					
1920	Albemarle Pippin	L. S. & B. M. 10-10-80 5-10-85	6 6 6	95 0 0	29.5
1919	Albemarle Pippin	L. S. & B. M. L. S. & B. M. B. Dust 80-10-10	4 4 4 4	87 95 20 34	94.3
SCAB					
1920	Winesap	D. L. S. & B. M. 80-10-10	7 7	96 88	68.4
	Stayman	D. L. S. & B. M. L. S. & B. M. 80-10-10	7 7 7	96 95 92	19.6
1917	Reagan	L. S. 40-40-20	1 1	66 73	22.2
	Gano	L. S. 40-40-20	2 2	95 84	38.2
	Ben Davis	L. S. 40-40-20	3 3	95 55	61.6

Abbreviations: L. S.—Lime-sulphur spray; D. L. S.—Dry lime-sulphur spray; B. M.—Bordeaux mixture; B. dust—Bordeaux dust.

Our previous experience with the use of sulfur dusts in apple scab control has been confined to experiments at Blacksburg in †1917, in which a 40 (sulfur)-40 (lime)-20 (arsenate of lead) dusting mixture was used in comparison with spray applications of lime-sulfur and arsenate of lead. There were 3 varieties in the experimental plats, Reagan, Gano and Ben Davis, which received one, two and three applications respectively of the dust and spray mixtures. The percentages of efficiency in scab control obtained with these applications are shown in Table 5 in comparison with the results for 1920. Comparisons are only possible, of course, between dust and spray plats of the same year since materials and number of applications in the two years were dissimilar. In 1920 the 80-10-10 dust gave nearly as high efficiency in scab control as the corresponding spray mixtures. This was also true for the 40-40-20 dust on the Reagan and Gano varieties in 1917, but the same material on the Ben Davis variety was much lower in efficiency than the lime-sulfur spray. Scab infection in the check plat of the latter variety was much more severe than in the check plats of Reagan and Gano.

Bitter-rot Control.—The tests were on the Albemarle Pippin variety, the trees being large and about 25 years of age. There were 30 trees in all, distributed among four plats. Six applications were made on each plat, except the check, on the following dates: May 3, 17, June 23, July 14, 29, August 26. The materials used on the plats were as follows:

Spray plat. Application 1, lime-sulfur; applications 2 to 6, 4-5-50 Bordeaux mixture. Lead arsenate was used in applications 1, 2 and 3.

Copper-lime dust, 10-10-80.

Copper-lime dust, 5-10-85.

Check.

Although bitter-rot was not especially severe, an adequate test of the materials was obtained. Codling moth was much more severe than in the Winesap and Stayman orchard. The percentages of sound apples and of apples affected with bitter-rot and codling moth are shown in Table 6. The number of apples in the plats varied from 1,877 to 15,769. It will be noted

TABLE 6.—*Percentages of defective and sound apples in dusting and spraying experiments on Albemarle Pippin in 1920.*

Plat	Bitter-rot	Codling moth	Sound
Check	29.5	29.6	47.0
Lime-sulfur & Bordeaux Mixture	1.4	2.5	96.3
Copper-lime dust, 10-10-80	30.7	7.6	63.6
Copper-lime dust, 5-10-85	41.5	6.3	53.7

†F. D. Fromme and W. J. Schœne, Dusting and Spraying for Apple Scab and Codling Moth, Annual Report Virginia State Entomologist for 1916-1917.

in the table that the percentages of sound and defective apples total more than 100. This is due to duplication, an apple injured by both bitter-rot and codling moth being counted under each.

Neither of the copper-lime mixtures proved at all satisfactory from the bitter-rot standpoint. By comparison with the check they apparently did not have any value whatever in the control of this disease. The Bordeaux spray, on the other hand, gave almost perfect control and reduced bitter-rot infection to a negligible amount. The spray applications were also more effective in the control of codling moth than the copper-lime dust.

A summary of our previous results with the use of various dusts in the control of bitter-rot and codling moth is shown in Table 5. None of the dust mixtures has proved sufficiently effective in the control of bitter-rot to warrant its use. Bordeaux dust in †1919 had an efficiency of only 20 as compared with 95 and 87 for the Bordeaux spray, and the 80-10-10 sulfur dust had an efficiency of 34. Neither the 5-10-85 nor the 10-10-80 copper-lime mixtures showed any measure of control of this disease in 1920. It is apparent that none of the dust mixtures should be used in orchards where bitter-rot is apt to be prevalent. There seems to be no justification for the use of any of the copper dusting mixtures in Virginia apple orchards.

The sulfur dust mixtures, the 40-40-20 in 1917 and the 80-10-10 in 1919, have proved practically as efficient in the control of codling moth as the corresponding spray materials. This is also true for the Bordeaux dust but the copper-lime dusts have not proved as effective as the spray mixtures.

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†F. D. Fromme and G. S. Ralston, Dusting Experiments in Peach and Apple Orchards, Virginia Agr. Exp. Station Bulletin 223. November, 1919.